SHILAP Revista de Lepidopterología
ISSN: 0300-5267
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Sociedad Hispano-Luso-Americana de Lepidopterología
España

Viidalepp, J.; Lindt, A.
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SHILAP Revista de Lepidopterología, vol. 40, núm. 158, junio, 2012, pp. 171-190
Sociedad Hispano-Luso-Americana de Lepidopterología
Madrid, España

Available in: http://www.redalyc.org/articulo.oa?id=45524831005

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SHILAP Revta. lepid., 40 (158), junio 2012: 171-190 CODEN: SRLPEF ISSN:0300-5267

A review of continental species of *Phrudocentra* Warren, 1895 (Lepidoptera: Geometridae, Geometrinae)

J. Viidalepp & A. Lindt

Abstract

A key to continental Neotropical species of *Phrudocentra* Warren, 1895, s. lat. is designed and provided with photos of moths and their male genital structures. The genus *Phrudocentra* Warren is redefined. Two subgenera are reinstated within *Phrudocentra* Warren, s. lat.: *Phrudocentra* Warren, s. str. (type species: *P. pupillata* Warren, 1897) and *Melochlora* Warren, 1901 (type species: *Tachyphyle neis* Druce, 1892). Three new genera are described: *Assachlora* Viidalepp & Lindt, gen. n. (type species: *Nemoria assa* Druce, 1892), *Lindachlora* Viidalepp & Lindt, gen. n. (type species: *Tachyphyle flaccida* Warren, 1909) and *Lissocentra* Viidalepp & Lindt, gen. n. (type species: *Melochlora hydatodes* Warren, 1906). Two species are found fitting with characters of the genus *Lissochlora* Warren, 1900: *Lissochlora niveiceps* (Prout, 1912) comb. n. and *Lissochlora senescens* (Prout, 1917) comb. n. One new species, *Assachlora julietae* Viidalepp & Lindt, sp. n. is described.
KEY WORDS: Lepidoptera, Geometridae, Geometrinae, *Phrudocentra*, *Assachlora*, *Lindachlora*, *Lissocentra*, new genus, new species, new combinations, Neotropical.

Una revisión de las especies continentales de *Phrudocentra* Warren, 1895 (Lepidoptera: Geometridae, Geometrinae)

Resumen

Se diseña una clave de las especies continentales Neotropicales de *Phrudocentra* Warren, 1895, s. lat., y se suministran fotos de los adultos y de las estructuras genitales de los machos. Se redefine el género *Phrudocentra* Warren. Se restituyen dos subgéneros dentro de *Phrudocentra* Warren, s. lat.: *Phrudocentra* Warren, s. str. (especie tipo: *P. pupillata* Warren, 1897) y *Melochlora* Warren, 1901 (type species: *Tachyphyle neis* Druce, 1892). Se describen tres nuevos géneros: *Assachlora* Viidalepp & Lindt, gen. n. (especie tipo: *Nemoria assa* Druce, 1892), *Lindachlora* Viidalepp & Lindt, gen. n. (especie tipo: *Tachyphyle flaccida* Warren, 1909) y *Lissocentra* Viidalepp & Lindt, gen. n. (especie tipo: *Melochlora hydatodes* Warren, 1906). En dos especies se encuentran que coinciden con las características del género *Lissochlora* Warren, 1900: *Lissochlora niveiceps* (Prout, 1912) comb. n. y *Lissochlora senescens* (Prout, 1917) comb. n. Se describe una nueva especie, *Assachlora julietae* Viidalepp & Lindt, sp. n.
PALABRAS CLAVE: Lepidoptera, Geometridae, Geometrinae, *Phrudocentra*, *Assachlora*, *Lindachlora*, *Lissocentra*, nuevos géneros, nueva especie, nuevas combinaciones, Neotropical.

Introduction

WARREN (1895: 90) presented a brief description of the new genus *Phrudocentra* for a new species, *Phrudocentra pupillata* Warren, 1897, supported by characters of wing shape and structure. Some years later, WARREN (1901: 445) described a genus *Melochlora* for *Tachyphyle neis* Druce, 1892, and *Nesipola* Warren, 1909, with the type species *N. impunctata* Warren, 1909 (synonymised with *P. centrifugaria* (Herrich-Schäffer, 1870) by PROUT, 1932).

PROUT (1912: 121) synonymised the two last genus group names with *Phrudocentra*, presenting for the first time a comparative morphological description of the genus. The heterogeneous assemblage of 28 species was divided into six species groups according to wing shape, characters of wing maculation and male tibial and female antennal characters. However, later (PROUT, 1932) he was constrained to separate *Phrudocentra* from closely related *Tachyphyle* Butler, 1881 (type species *Tachyphyle acuta* Butler, 1881) only by an absence of derived characters (loss of proximal spurs in male hind tibia, longer anal margin of hindwings, shorter palpi in the latter), and to forget the informal species groupings presented earlier. According to the recent paradigm, the genus *Phrudocentra* was supported by symplesiomorphic characters.

PITKIN (1996) presented a comprehensive description of the morphology of included species, discussing the variability of characters within the group-e. g., reduction of frenulum in male of *Phrudocentra tanaoptera* (Prout, 1916) and *P. obnubilata* (Warren, 1906). PITKIN (1993) characterized the genus by the specific shape of wings (forewing tip produced and distal margin of forewing convex or sinuous), by dark maculation of the hind wings' underside, by the pear-shape of male genital capsule, but mentioned some species as different from the usual in their wing pattern or build of genital structures, e. g. *P. hydatodes* (Warren, 1906) and *P. vitiosaria* (Dognin, 1892).

Dichorda porphyropis Prout, 1925*, Phrudocentra flaccida* (Warren, 1909), *P. tanystys* Prout, 1931 and *P. niveiceps* Prout, 1912 were informally referred to as "rejected species" under *Dichorda* Warren, 1900 and *Phrudocentra* Warren, 1895, accordingly.

There are thirty-four species grouped within *Phrudocentra* according to PITKIN (1996); 30 of them are discussed below. Two specimens have remained unidentified and unnamed; fresh material is needed for unambiguous characterization of these taxa.

Material and method

The present study was initiated by attempts to identify the moths accumulated in Estonian state and private collections, the material collected by expeditions of the Estonian Museum of Natural History and the Estonian University of Life Sciences to different parts of the Neotropical continent, 1999-2010. Series of moths collected by A. Lindt (Tallinn) in Ecuador, Costa Rica and Bolivia, by A. Selin (Tallinn) in Ecuador, Venezuela, Costa Rica and Chile, by T. Kesküla (Tartu) in Ecuador and I. Renge (Tartu) in French Guiana, by the author in French Guiana and Nicaragua, served for comparative morphological investigation. The Sys-Resource stipendium to the British Museum of Natural History presented a possibility to examine the famous collection which is rich in primary types, and the collection of C. Herbulot was visually examined in ZSM (München).

Continental species of *Phrudocentra* are dealt with below. Caribbean and Mesoamerican species (*P. agari* Prout, 1916, *P. centrifugaria* (Herrich-Schäffer, 1870), *P. kinstonensis* (Butler, 1878), *P. leuconyssa* Prout, 1932 (a specimen with whitish postmedial line in forewing underneath, but with abdomen absent, in coll. BMNH examined), and *P. oubrica* (Dyar, 1914)) are excluded due to the absence of fresh material in those collections visited. However, the identity of *P. condensata* (Warren, 1907), *P. sordulenta* Dognin, 1923 and *P. tanaoptera* (Prout, 1916) (with frenulum of male reduced) has remained obscure.

The investigation method included mapping of specific characters and measurements of antennae, legs, venation of wings and genital capsules from different geographical populations. A binocular microscope MBS-1 with ocular scale was used, measurements were taken under 40 x magnification. Comparative morphological study at an early stage soon revealed some variation in morphology of specimens from different origins (VIIDALEPP & LINDT, 2009).

The relations between species were studied by compiling a matrix of characters and analyzing it by means of application of parsimony program Hennig86. However, the results yielded by the computation of 125 species-level characters for 81? species and 29 genera will be discussed elsewhere. Here only apomorphic characters revealed using option 'xsteps h', of the application are used for

delimiting subgenera within *Phrudocentra*. Moths were photographed using a Canon 300D camera, genital slides made with a digital camera Leica EC3, photos enhanced using Adobe Photoshop.

Key to the species: conventions

For length of antennal pectinations, external pectination on the tenth segment is measured by means of an ocular micrometer at 40x magnification; the length of parts of male hind tibia and tarsus, the length of the longer proximal spur when compared to distance from base of proximal spurs to the base of distal spurs in dry specimen or in permanent slide is measured the same way. The length of tibial process (the cover slip of the apical part of hair pencil) in male is measured from its tip to the base of distal spurs on inner side of tibia, and compared to length of basal tarsomere (t1). The length of the 3rd segment of palpus is given for males and females according to availability of material.

Key to the species

1(50) Vinculum larger than tegumen, relatively thin, distended.....2

2(9) Forewing apically falcate (sharply angulate in *mitigata*). Juxta with long filiform dorsal processes (Plate 3); aedeagus strongly curved (***Assachlora*** **Viidalepp & Lindt, gen. n.**).....3

3(6) Wings green above without brown or ochreous tint. Dorsal processes of juxta long, arched. Uncus parallel-sided, sternite A8 indented about one-fifth to one-half of its length posteriorly and provided with a small central projection at middle of its anterior margin 4

4(5) Wings below dark greenish grey, forewing postmedial line and hindwing costal area whitish. – Forewing falcate apically, wing span 25 (male) - 30 mm (female). Wings above green with distinct whitish postmedial, strongly shaded olive green proximally; forewing apical spot present underneath, small; hindwing rounded distally (Plate 1, figs. 1, 5). Frons light brown. Male antennae pectinate, pectinations' length 0.7-0.75 mm, 3rd joint of palpus 0.3 mm long in male, 1.0 mm in female. Male hind tibia with distal process 0.75 mm long. Sternite A8 1.0 mm long, shortly bilobed distally. Aedeagus curved rectangularly, distally with a fine serrate ridge. Armature 2.27 mm high, juxta processes 1.12 mm long (Plate 3) .....*A. assa* (Druce, 1892), **comb. n.**

5(4) Wings below pale green, distally even paler; postmedial band not visible, grey spot between discal cell and anal margin of hindwing smaller than in *A. assa* (Druce). - Wing span 26-27 mm in male. Wings above green, discal spots in hindwing ringed grey and larger than in forewing; forewing apical spot absent, postmedial straight, incontrasting, shadowed proximally darker green (Plate 1, figs. 9, 13). Male antennal pectinations 0.75 mm, female antenna filiform; 3rd joint of palpus 0.3 mm long in male, 0.7 mm in female; male hind tibia with pencil and distal projection about 1.2 mm. Sternite A8 1.2 mm long, its distal lobes of one-half of sternite length, sclerotized inwardly (Plate 3). Aedeagus strongly curved, 2 mm long, with a thin smooth apical spine (0.13 mm long); genital armature 2.45 mm high, distal processes of juxta strongly curved, 1.4 mm long .....*A. mitigata* (Prout, 1912), **comb. n.**

6(3) Wings underneath suffused with ochreous or yellowish brown; dorsal processes of juxta reaching gnathos, curved or straight; uncus broader apically; sternite A8 split to its base medially. Forewing produced apically, with postmedial line whitish, straight from near apex to hind margin of hindwing; wings above green (in mountains above about 1700 m) or brownish (lowland to about 1600 m).....7

7(8) Dorsal processes of juxta less than 1.05 mm long, broader and straight. Aedeagus 1.6-1.7 mm long (Plate 3).- Wing span 21-22 mm (Plate 1, figs. 2, 6). Frons and fillet white, vertex and thorax green. Male antennal pectinations 0.5 mm, 3rd joint of palpus 0.28 mm in male, 0.9 mm in female. Length of male hind tibia 3.75 mm, its distal process 0.75 mm, longest proximal spur 0.87 mm, distance between

spur pairs 0.62 mm; pencil present, longest distal spur as long as tibial projection .... ***A. julietae*** **Viidalepp & Lindt, sp. n.**

Holotype male: Bolivia / Sacramento Alto, 2500 m / 12.11.2010 /A. Lindt leg. Paratypes: 1 male, Bolivia / Sacramento Alto, 2500 m / 12.11.2010 /A. Lindt leg. // Genit. prep./ 8590 / Viidalepp; 1 male, Bolivia / National Park Tarasco / 900 m 05.10.2010 / leg.A. Lindt; 1 male, Peru" // Genit. prep./ 7268 / Viidalepp. Holotype will be deposited in coll. Museo Historia Natural Noel Kempff Mercado, La Paz, Bolivia. Paratypes deposited in Estonian Museum of Natural History, Tallinn, Estonia.

8(7) Dorsal processes of juxta slenderer, 1.25 mm long. Aedeagus slenderer, nearly filiform, 1.75-1.8 mm long (Plate 3).- Wing span 22-24 mm in males (Plate 1, figs. 3-4, 7-8), 24-26 mm in females. Frons and fillet white, vertex green; female antennae filiform, male antennal pectinations 0.55 mm, 3rd joint of palpus slender, 0.25 mm in male, 0.75-0.8 mm in female. Hindtibia 4.0 mm long, distal process spine-like, 1.0 mm long, spur pairs' distance about 0.75 mm,. Pencil present. Longest distal spur as long as tibial projection. .....*P. subaurata* (Warren, 1904)

/Superficially similar species: *Tachychlora subfulvata*, smaller (wings span 21-22 mm), hindwing discal mark linear, grey, 3rd joint of palpus shorter, forewings' distal margin less sinuous, proximal spurs absent in male hind tibia, distal spurs very unequal (4:1 to 5:1). Wings below darker grey, paler at costa and distal margin. Male antennal pectinations 0.42-0.45 mm long. /

9(2) Forewing apically not falcate. Sternite A8 posterior margin straight, weakly indented or slightly bilobed; juxta without dorsal processes, aedeagus straight.....10

10(15) Interantennal fillet with a thin reddish line (some tan scales in *marcida*) between its white distal and green basal parts; frons green (subgenus *Phrudocentra*) 11

11(12) Male hind tibia with its apical process absent or short (0.15 mm) (Plate 8). Hindwing below with a grey patch between cell base and anal margin.- (Plate 1, figs. 10, 14).Tibial hair pencil present, short, antennal pectinations 0.37-0.5 mm long, 3rd joint of palpus 0.18-0.22 mm in male, 0.75 mm in female. Uncus length 0.62-0.64 mm, aedeagus basally broad and truncate, distally with two hooks, 1.55-1.63 mm long, its sclerotized rib 0.75-0.95 mm (Plate 4) .....*P. vivida* (Warren, 1901)

12(11) Male hind tibia with apical process present.....13

13(14) Hindwing below with grey spot between the base of discal cell and anal margin (Plate 1, figs. 11, 15). Hindtibial apical process 0.9-1.15 mm long (Plate 8).- Tibial hair pencil present, longer than in *P. vivida*, antennal pectinations 0.37-0.45 mm, 3rd joint of palpus 0.2-0.26 mm long in male, 0.63-0.66 mm in female. Uncus 0.5-0.62 mm long, apically flat. Aedeagus (1.3?) 1.6-1.9 mm long, with a projecting rib (1.0-1.5 mm) and a lateral row of short (0.25-0.5 mm) spines (Plate 4)..... .....*P. pupillata* Warren, 1897

14(13) Hindwing below without a grey spot but with a broad green submarginal band. Hindtibial apical process 0.33-0.37 mm long.- Forewing without an apical spot, distal margin of hindwing rounded (Plate 1, figs. 12, 16). Antennal pectinations 0.33 mm in male, 3rd joint of palpus 0.2 mm long in male, 0.63 mm in female. Uncus dilated apically, its length 0.6-0.7 mm, aedeagus basally broad, distally cut, 1.62-1.82 mm long, rib 1.0-1.14 mm, apical cornutus 0.7 mm, laterally a dense group of long, distally directed spines (Plate 4).....*P. marcida* (Warren, 1901)

15(10) Fillet without a red line, green or white and green (subgenus *Melochlora*).....16

16(25) Forewing above green with distal or tornal area contrastingly banded or spotted blackish brown 17

17(18) All wings with distal third plain black (Plate 2 – 25). (See 57) .....*P. nigromarginata* (Dognin, 1911)

18(17) Wings' submarginal area variegated green and brown to black, not plain black; white spots at tergites surrounded by fuscous scales 19

19(22) Forewing postmedial line wavy, black, and tornal area broadly blackish. Tibial pencil present 20

20(21) Uncus sclerotized rigid, short and broad stamp-shaped (Plate 4).- Frons green and white, fading to golden yellow; fillet white and grey posteriorly, vertex green, thin white line between; male antennal pectinations (0.5) 0.62-0.67 mm long, 3rd joint of male palpus 0.2-0.25 mm. Distal projection of tibia absent, pencil present. Uncus specific, rigid, 0.75-0.8 mm long and 0.8 mm broad at base; aedeagus 2.75-3.3 mm long, provided with laterodistal hook (0.7-0.75 mm long). No difference found to diagnose eastern continental nominative form and f. *tenuis* from Mesoamerica (Plate 1, figs. 17, 21) ....*P. janeira* (Schaus, 1897)

21(20) Uncus normal, flexible, basally slenderer (Plate 4). Frons green with four white marks at corners; fillet white with a green spot ahead of it, and green behind the antennae (Plate 1, figs. 18, 22). Male antennal pectinations 0.75 mm long, 3rd joint of palpus dark, 0.2-0.25 mm long. Aedeagus slenderer, 2.6 mm long, its laterodistal sclerite 0.7 mm long, nearly straight, tapered obliquely distally, not hooked like in *janeira*. Identity doubtful, re-investigation of types needed. If synonymic, *janeira* will be the valid name for this species as well .....*P. vagilinea* (Warren, 1906)

22(19) Forewing postmedial line straight, whitish, tornal area with 2-3 fuscous marks (sometimes fused).....23

23(24) Forewing subtornally with 3 fuscous marks (Plate 1, figs. 19, 23). Aedeagus pointed distally.- Frons green, fillet and vertex green, thin white line between; male antennal pectinations 0.67-0.75 mm long, 3rd joint of palpus 0.25-0.28 mm; male hind tibia with a short pencil, without distal process. Uncus 0.75-0.8 mm long, apically thickening, aedeagus slender, (1.77) 2.0-2.5 mm long with stronger rib 1.7-1.75 mm; coremata strong but short (Plate 5). Forewing submarginal dark band is slightly broader in series from Ecuador, slenderer in moths from France Guyana; no differences in morphology found.....*P. neis* (Druce, 1892)

24(23) Forewing subtornally with 2 fuscous marks. Hindwing below with grey markings reduced. Aedeagus rounded distally.- Identity doubtful, investigation of types needed; if synonymic, *neis* will be the valid name for the species…Genitalia similar to *P neis* (Plate 5).....*P. inguilina* (Dognin, 1911)

25(16) Forewing green above, often incontrastingly suffused fuscous along the distal and anal margin and/or proximally to the postmedial line 26

26(31) Forewing underside with broad blackish distal band which is sharply projecting towards the wing base between the discal cell and anal margin.....27

27(28) Hindwing above with 2-3 oblong grey marks between veins in apical area (Plate 1, figs. 20, 24).- Frons slender, green; fillet and vertex green with white line in between, male antennal pectinations 0.7 mm, 3rd joint of palpus 0.4 mm. Postmedial line deep green; bluish lustrous shine sometimes well developed; hindwing below with fuscous hue between the basal and postmedial grey bands. Male genitalia: (Plate 5).....*P. trimaculata* (Warren, 1901)

28(27) Hindwing above without apical grey markings.....29

29(30) Aedeagus thin filiform, without a cornutus, 2.0 mm long (Plate 5). – Wing span 30 mm, length of male antennal pectinations 0.75-0.8 mm; 3rd joint of palpus 0.35-0.37 mm long; male hind tibia

without pencil and distal process; forewing underside with broad distal band, projecting broad along hind margin towards wing base, hindwing below paler than forewing, distal grey band broad but shifted medially and slenderer than its distance from wing margin (Plate 1, figs. 25, 29) ....*P. intermedia* (Warren, 1904)

30(29) Aedeagus about 2.25 mm long, flat, with a straight prong and cornutus distally (Plate 5).- Wing span 27.5-29 mm. Frons, fillet and vertex plain green. Forewing apical spot large, fuscous hue covering broadly the anal half of forewing and hindwing. Forewing underside blackish submarginal band slender against discal cell, broadening over the whole anal field; hindwing basally whitish fuscous, apical part largely fuscous and obliquely demarcated subanal area pale greyish (Plate 1, figs. 26, 30). Length of male antennal pectinations 0.4-0.45 mm; 3rd joint of palpus 0.35 mm; hind tibia with hair pencil, without apical projection .....*P. contaminata* Prout, 1916

31(26) Forewing anal area below whitish, without grey keel projecting from tornal area inward.....32

32(43) Aedeagus with an apical, diverging stick-like cornutus. 33

33(38) Aedeagus with apical, diverging cornutus straight, not hooked.....34

34(37) Aedeagus about 2.0 mm long 35

35(36) Hindwing beneath, discal spot surrounded by a large grey cloud. The diverging cornutus about 0.5 mm long.- Male hind tibia without distal process and pencil (Plate 8); male antennal pectinations about 0.34-0.4 mm long, 3rd joint of palpus 0.25 mm long; female antenna finely dentate, 3rd joint of palpus 0.35 mm long; frons green with white line above and white corners below, fillet white, vertex green. Hindwing underneath, discal spot large, oblong, ground colour of middle paler, distal part darker green (Plate 1, figs. 27, 31; Plate 5) .....*P. discata* (Warren, 1909)

36(35) Hindwing discal spot small, blackish, without surrounding grey cloud. The diverging cornutus about 0.37 mm long (Plate 6).- Male hind tibia with a thin hair pencil, without or with short distal projection; male antennal pectinations 0.55 mm long, frons white, vertex white anteriorly and green behind (Plate 1, figs. 28, 32).....*P. albiceps* (Warren, 1904)

37(34) Aedeagus 2.25 mm long or longer; diverging cornutus 0.5-0.6 mm long. Hindwing underneath ground colour yellowish, that of forewing green; male hind tibia without distal process, with a short hair pencil; male antennal pectinations 0.45-0.55 mm long, female antenna pectinate (like in *P. opaca*, 0.5 mm long); fillet white with a green spot anteriorly, vertex white and green (Plate 2, figs. 1, 2, 5, 6; Plate 6) .....*P. albicoronata* Prout, 1916

38(33) Aedeagus with diverging cornutus apically hooked or S-shaped.....39

39(40) The diverging cornutus apically hooked. Aedeagus 2.25 mm long (Plate 6). Both fore- and hindwing relatively dark green below, with grey maculation slenderer.- Male antennae pectinate, 3rd joint of palpus black, 0.23-0.25 mm long. Hindtibia without hair pencil and distal process; frons green, fillet green, with white line posteriorly (Plate 2, figs. 3, 7).....*P. abscondita* (Warren, 1909)

40(39) Aedeagus with diverging cornutus curved S-shaped.....41

41(42) Wings above green without a concrete grey spot at forewing tornus. Hindwing ground colour below whitish or yellowish, forewing green.- Wing span 25-26 mm, frons green, fillet broad white, anteriorly greenish; antenna pectinate in both sexes, with pectinations 0.5 mm long; 3rd joint of palpus 0.22-0.26 mm long in male; male hind tibia without hair pencil and distal process. Male with frenulum not reduced. The diverging cornutus tapering to a point apically (Plate 6). Hindwing underneath,

postmedial grey band slenderer than its distance to wing margin (Plate 2, figs. 4, 8)..... .....*P. opaca* (Butler, 1881)

42(41) Forewing above, with a concrete grey spot at tornus; brownish grey suffusion strong on both wings. Hindwing below largely fuscous with a faint pale band across middle, and broader pale greenish band along outer margin (Plate 2, figs. 9, 13). / Underside of wings similar to that in *P. hydatodes* (Warren, 1906). / Wing span 26 mm. Frons and fillet light green, vertex green, separated by a white line; 3rd joint of palpus 0.2 mm long in male; antennal pectinations about 0.5 mm long in male; uncus produced linear, not bulbed at tip; aedeagus flat, and short (Plate 7).....*P. obnubilata* (Warren, 1906)

43(32) The distal cornutus, if present, lies in parallel to the longitudinal sclerotization of aedeagus, not hanging or diverging aside 44

44(47) Aedeagus with a long sclerite ending distally fish-tail shaped or obliquely cut. Wing span 24 mm or less, forewing medial field paler green than basal and distal area, hindwing below with the postmedial band reduced to spot at costa and a pair of spots subanally Hindtibia slender, without pencil and apical process 45

45(46) Wing span 24 mm. Frons green, broad and round, fillet white with fore margin light greenish, vertex green. Male pectinations 0.45 mm long (three times longer than shaft wide, stronger than in *genuflexa*), 3rd joint of palpus grey, 0.2 mm long; Aedeagus 2.35 mm long, cornutus obliquely tapering distally; uncus broader apically, 0.75 mm long; coremata short but thick, blackish (Plate 7). Underneath, dull grey markings relatively slender in forewing, almost separated from wing distal margin and tornus, in hindwing slender as well, reduced to a band of greenish grey hue and grey spots at costa and between M3 and Cu2 (Plate 2, figs. 10, 14).....*P. eccentrica* Prout, 1916

46(45) Wing span 23-24 mm. Frons slenderer than in *eccentrica*, green, fillet white, broad, vertex green. Male antennal pectinations 0.5 mm long, 3rd joint of palpus 0.25 mm. Underneath pale greenish, forewing with dark grey band as slender at discal cell as its distance from wing margin, broadening behind the vein M3 and covering tornal 2/5 of anal area; hindwing with antemedial grey band slender and of equal width, postmedial grey band reduced to one costal and two subanal spots, with slight greenish grey hue between (Plate 2, figs. 11, 15). Aedeagus 2.75 mm long, the outstanding stick 0,7 mm long, the longer rib distally fishtail-like bidentate (Plate 7).....*P. genuflexa* (Warren, 1906)

47(44) Wing span 25 mm or more; combination of characters different.....48

48(49) Wings not paler distally. Aedeagus thin and long (3.0 mm) with flat blind end, without apical cornuti; uncus apically broad, wine-glass shaped, 0.75 mm long; cochlear strong.- Male antennal pectinations 0.55 mm, 3rd joint of palpus grey, 0.25 mm long; sternite A8 not indented posteriorly; similar to *albicoronata* but without diverging cornutus .....*P. condensata* (Warren, 1907)

49(48) Wings plain green with distal margin pale green and fringe white. Frons, fillet and vertex white. Aedeagus 2.1-2.2 mm long with characteristically flat cornutus hooked sidewise-Wing span 25-27 mm in male, 30 mm in female. Ante- and posmedial lines pale bluish, slightly shadowed darker green; below, grey spots at forewing tornus, hindwing apex and between cell base and anal margin (Plate 2, figs. 12, 16). Uncus apically broader, 0.8 mm long (Plate 7).....*P. taediata* (Felder, 1875)

50(1) Vinculum not distended.....51

51(54, 55) Male hind tibia with spurs almost equal length (inner spurs not markedly longer). Wings light green with brown or blackish markings late 2). Uncus spoon-shaped dilated apically, a bare line separating hairy pads at its ventral side. Valva with sclerotized costa, demarcated by lacinia costalis against valvula. Frons flat, sloped, dark brown as fillet and vertex. Male antennal pectinations as long

as shaft broad (0.25 mm), numbering 32, palpus broad, 3rd joint minute. Hindtibia with distal process 0.5 mm long, proximal spurs of equal length, shorter than the distance between spur pairs (Plate 8). ***Lindachlora*** **Viidalepp & Lindt, gen. n**.....52

52(53) Wing span 31-33 mm, forewing with brown basal part and antemedial line, while postmedial line mostly indicated by spots at veins (Plate 2, figs. 17, 20).- Uncus dilated apically, 1.6 mm long, and 0.58 mm broad at apex, aedeagus 1.88 mm long (Plate 7) Peru, Ecuador.....
.....*L. flaccida* (Warren, 1909), **comb. n.**

53(52) Wing span and pattern as in *P. flaccida* but male antennae with about 36 pectinations as long as shaft thick (Plate 2, figs. 18, 21). Uncus shorter (1.3 mm long) and apically broader (0.7 mm) (Plate 7). Eastern South America.....*L. tanystys* (Prout, 1931), **comb. n.**

54(51) Wing span 26 mm. Distal third of both wings uniformly black (Plate 2, fig. 25). Valva simple, slender, coremata small.- Frons black, fillet black ahead of antennae and white posteriorly, vertex green. Male antennal pectinations about 0.25 mm long. Proximal spurs to male hind tibia short and equal (Plate 8), shifted to the base of distal spurs like in *Tachyphyle*. However, the missing of other characters of *Tachyphyle*-the presence of harpe and forked uncus – exclude the closer relationship with any species of that genus. Uncus 0.75 mm long, thicker towards apex, aedeagus small, 0.95 mm long; gnathos very long, coremata absent (Plate 7) .....*P. nigromarginata* (Dognin, 1911)

55(51) Distal third of wings not contrastingly black, wing span less than 30 mm 56

56(59) Socii long, linear, tapering apically (Plate 8). Valva with costa sclerotized plate-shaped abd demarcated by lacinia costalis. Wings above monotonous olive greenish-grey; male hind tibia with pencil and distal process present 57

57(58) Wings span 25 mm, greyish green, paler distally as in *P. taediata*; discal spots tiny, transverse lines slightly darker olive greenish (Plate 2, fig. 26).- Frons and palpi greyish, fillet white, vertex green. Male antennal pectinations as long (0.12 mm) as the shaft broad, 3rd joint of palpus short conical (0.1 mm). Male hind tibia provided with pencil and distal process (0.5 mm), proximal spurs shorter than the distance between spur pairs .....*Lissochlora niveiceps* (Prout, 1912), **comb. n.**

58(57) Wings span 23 mm, olive greenish with fuscous hue, submarginally purer green. Discal spot larger in forewing than in hindwing, ante- and postmedial lines indicated by blackish maculation at veins (Plate 2, figs. 18, 22).- Frons green, fillet white, vertex green; male antennal pectinations as long as the shaft is thick (0.16 mm), 3rd joint of palpus short conical (0.12 mm). Hindtibia with distal process 0.67-0.7 mm long, longer than the longest distal spur. The longer proximal spur exceeding the distance between spur pairs .....*Lissochlora senescens* (Prout, 1912), **comb. n.**

59(56) Wings above glossy olive grey to brownish, with a triangular pale blotch at forewing costa; male hind tibia without a pencil and distal process. Valva simple, not sclerotized costally, socii small, juxta a short plate, gnathos long with cochlear long and sharp-tipped; aedeagus short, table-knife shaped. Coremata short or reduced .....***Lissocentra*** **Viidalepp & Lindt, gen. n.**…60

60(61) Hindwing discal spot blackish (Plate 2, figs. 19, 23).- Frons grey, fillet white, vertex green. Male antennal pectinations 0.4 mm long, palpi white with 3rd joint conical, short (0.14 mm). Male hind tibia without pencil and distal projection, spurs very long (Plate 8). Male genitalia-Plate 8 .....
.....*L. hydatodes* (Warren, 1906)

61(60) Hindwing discal spot whitish (Plate 2, figs. 20, 24).- Frons and vertex green, palpi and fillet white. Male antennal pectinations 0.5 mm long, palpi white with 3rd joint conical, short. Moths with wings distally, above and below, usually more pale brownish than in *P. hydatodes*, but may be also

quite similar to these in facies; the white discal spot in hindwing remains diagnostic. Male genitalia-Plate 8.....*L. vitiosata* (Dognin, 1892) **comb. n.**

Discussion: *Phrudocentra* and other Nemoriini genera

The Nemoriini are distributed in the New World and tropics of the Indo-Australian region. Nemoriini genera have a characteristically modified sternite in the pre-genital segment of male, with sclerotized central axis and bilobed posterior margin. Thirty seven genera are housed in live the Neotropical region and may be defined by characters of antennae, male hind legs (relative length of tibia and tarsus; presence or absence of an androconian hair pencil and distal projection, number and position of spurs on male hind tibia), and venation of wings. Four of these genera have semi-transparent, light greenish wings: *Cathydata* Prout, 1912, *Chloractis* Warren, 1895, *Hyalochlora* Prout, 1912 and *Neagathia* Warren, 1897. The corresponding species are diagnosed by their wing pattern. Other genera have denser green scaling on both wings. *Tachyphyle* Butler, 1881 and *Tachychlora* Prout, 1912 have proximal spurs in male hind tibia almost lost or strongly reduced; the first has hind wings which are green, the latter -marked with yellow. (Also one *Rhodochlora* Warren, 1894 species possesses only distal spurs in male hind legs.) *Rhodochlora* species are the largest emerald moths in the region.

Other Nemoriini genera have male hind tibia provided with two pairs of spurs and inner spurs about two times longer than external spurs: the proximal and distal pair of equal length (except "*Phrudocentra*" *flaccida* Warren which is discussed below). *Rhodochlora* and *Pyrochlora* Warren, 1895 have frons scaled reddish or bright brownish yellow, other genera - green, white or (seldomly) blackish brown but not rouge.

Chavarriella Pitkin, 1993, *Dichorda* Warren, 1900, *Eualloea* Warren, 1909, *Poecilochlora* Warren, 1904, *Paromphacodes* Warren, 1897, *Lissochlora* Warren, 1900 and *Nemoria* Hübner, [1818] 1816, have plain underside of wings and male hind tibia relatively longer than tarsus, with the distance between spur pairs usually exceeding the length of spurs. *Phrudocentra* has male hind tibia shortened, shorter than tarsus, and especially the distance between spur pairs is often shorter than the longest proximal spur. *Phrudocentra* and *Pyrochlora* share the presence of dark markings on the underside of wings but differ considerably in colour of frons. Both *Tachyphyle* and *Phrudocentra* have forewings which are often slightly falcate at tip, *Tachyphyle* differing in considerably shortened male hind tibia, the black tips of reduced proximal spurs visible just near base of the distal pair of spurs.

Consequently, the genus *Phrudocentra* is diagnosed as having a pear-shaped distended male genital capsule associated with large, extensile androconial hair pencils, large plate of juxta and simple valvae without costal sclerotization, small socii; slightly sinuous distal margin of forewing, palpus longer in female than in male, and two pairs of spurs present in male hind tibia. Following characters vary within the genus: colour of frons; length of antennal pectinations in male and female; thickness of frenulum in male; male hind tibia dilated and provided with a strong hair-pencil and distal projection present, or slender, tufted short if all, and without distal process; hindwing termen rounded or slightly angulate at the vein M_1; the shape of juxta and that of sternite A8 in male.

The condensed tree yielded through parsimony analysis (with *Dysphania militaris* (Linnaeus) as an outgroup species) placed most *Phrudocentra* species basally to the tree, followed by *Tachyphyle*, *Tachychlora* and other genera; worth of mention that the, Indo-Australian genus *Eucyclodes* Warren was placed as the most specialized crown group.

Compiling the recent review, it became obvious that the recent composition of *Phrudocentra* is not monophyletic: e. g., *P. subaurata* (Warren, 1904) and allied species possess a long dorsal process to juxta and a deeply incised last abdominal sternite, differing from others in the absence of dark maculation and presence of rich golden or yellow-brown suffusion on wings. Some other

species have a male genital capsule of normal shape, not distended (i. e. the vinculum not enlarged) and even associated with some other genital characters.

Results: Structure of *Phrudocentra* sensu latu

The genus type, *P. pupillata* Warren, 1897 shares with *P. vivida* (Warren, 1901) and *P. marcida* (Warren, 1909) characters as follows: **1**) male hind tibia dilated, with relatively short spurs and the distance between spur pairs longer than proximal spurs; **2**) head with a red stripe between white interantennal fillet and green vertex; **3**) male has a group of short (long in *P. marcida*) spines latero-distal to aedeagus, a possible homology with aedeagus ornamentation in *Tachychlora.* The shape of hind wing is specific but hard to diagnose (Plate 1), and dark marks on the underside are localized at anal margin of hind wing. Male sternite A8 only is slightly only incised at distal margin, aedeagus is thin and straight, and juxta simple, large, plate-shaped. Strictly delimited, it should be the subgenus *Phrudocentra* sensu stricto.

Numerous species share the genus-group characters with the preceding group but have hind wings projecting angulate at vein M3 and male hindtibial spurs longer. *P. neis* (Druce, 1892) (the type species of *Melochlora*) and allied species share hindtibial proximal spurs long, longer than the distance between spur pairs (Plate 8), and hindwing distal margin more or less angulate at the vein M_1. Light ante-and postmedial lines are often edged dark green, olive green or brownish above in wings and variously patterned or suffused dark grey underneath. Juxta and sternite A8 as in the previous group of species. Aedeagus is straight, with an apical cornutus present or absent.

This most speciose species group has a valid name, *Melochlora* Warren, 1901, for the subgenus. It embraces the informal sections III-V by PROUT (1912). *Phrudocentra janeira* (Schaus, 1897), *P. vagilinea* (Warren, 1896), *P. neis* (Druce, 1892), *P. inguilina* (Dognin, 1911), *P. trimaculata* (Warren, 1901), *P. intermedia* (Warren, 1904), *P. contaminata* Prout, 1916, *P. discata* (Warren, 1909), *P. albiceps* (Warren, 1904), *P. albicoronata* Prout, 1916, *P. abscondita* Prout, 1932, *P. opaca* (Butler, 1881, *P. obnubilata* (Warren, 1906), *P. eccentrica* Prout, 1916, *P. genuflexa* (Warren, 1906), *P. condensata* (Warren, 1907) and *P. taediata* (Felder & Rogenhofer, 1875) belong to the subgenus *Melochlora*. The position of *P. nigromarginata* Dognin, 1911 remains disputable.

Phrudocentra assa (Druce, 1892), *P. subaurata* (Warren, 1904), *Assachlora julietae* Viidalepp & Lindt, sp. n., described above and *P. mitigata* Prout, 1912 share with previous subgenera such generic characters as distended vinculum and extensile coremata pencils (Plate 3), have two pairs of long spurs in male hind tibia longer than the distance between spur pairs as in the preceding group of species and merely a grey spot to hindwing underneath as the *P. pupillata* group above. However, juxta provided with a pair of long, filiform dorsal appendages (Plate 3), a strongly curved aedeagus and a deeply incised or bipartite sternite A8 are synapomorphies of the present group, supported by rich yellow-brown suffusion on wings' underneath and a falcate shape of forewing, evaluated as genus-rank characters excluding it from *Phrudocentra* a. o. nemoriine genera. A new genus name, ***Assachlora* Viidalepp & Lindt, gen. n.** (type species: *Phrudocentra assa* Druce, 1892) must be instated. PROUT (1912) separated these species in his informal II section.

Some species are marked as "Generic placement uncertain" by PITKIN (1996) (*"Phrudocentra" flaccida* (Warren, 1909) and *"P". tanystys* Prout, 1931; *"P." niveiceps* Prout, 1912, *P. hydatodes* (Warren, 1906), *P. vitiosaria* (Dognin, 1892)).

P. flaccida (Warren) was described from Peru, *P. tanystys* Prout, from Santa Catharina, East Brazil, with only one objective morphological difference between the two, male antennal pectinations more numerous in the eastern taxon. Although it is subjective to decide, about 32-34 pectinations are longer than the diameter of shaft in antenna of males from Ecuador, and 36-40 segments are supposed to be pectinated in almost similar moths from French Guyana - i. e. we suppose that the Ecuadorian series represents *flaccida* and that from French Guyana - *tanystys.* There are some differences in details of male genitalia: uncus is longer and slenderer in the French Guyana material, shorter and apically broader in the series from Ecuador. The whole genital capsule

and sternite A8 are larger in the eastern population, capsule smaller and sternite A8 slenderer in Ecuador. Further material is needed from Brazil to understand if we have a case of clinal variation or two vicarian species - as supposed by Prout.

However, the species or pair of species lacks the specific characters of the genus *Phrudocentra* listed above. Spurs in male hindleg are shorter than the distance between spur pairs and inner spurs are almost the same length as external spurs. Male genital capsule is not distended, vinculum is even shorter than tegumen; coremata tufts are much short. Costa of valva are sclerotized, concave dorsally and delimited by lacinia costalis against valvula; gnathos is long and provided with spoon-shaped cochlear (in *Phrudocentra*, gnathos tip is a tapering hook). There is no dark maculation underneath on wings. Uncus is spoon-shaped broad at apex and densely setose ventrally, with a distinct bare stripe separating pads of setosity - a genus-rank autapomorphy for ***Lindachlora*** **Viidalepp & Lindt, gen. n.** (type of the genus: *Tachyphyle flaccida* Warren, 1909).

Phrudocentra niveiceps Prout, rejected from the genus by PITKIN (1993), and *P. senescens* Prout differ from characterization of typical *Phrudocentra* in structure of male genitalia: genital capsule not distended ventrally, tegumen slightly longer than vinculum; valva with costa sclerotized and edged ventrally by lacinia costalis; socii linear, longish; gnathos produced at tip; juxta a small plate with weak papilla ventrally. Sternite A8 is shorter than tergite A8 sclerotized medially and at posterior margin. Both moths are structurally similar to *Lissochlora* as diagnosed by PITKIN (1993), especially to *L. latuta* (Dognin, 1898) in configuration of male genitalia, but differing in duller greenish grey ground colour of wings. New combinations *Lissochlora niveiceps* (Prout, 1912), **comb. n.** and *Lissochlora senescens* (Prout, 1917), **comb. n.** are proposed.

The last pair of species of dubious affinity, *"Phrudocentra" hydatodes* (Warren) and *"P." vitiosaria* (Dognin), has phrudocerine shape of wings, antennae and palpi, sharing slender male hind legs with proximal spurs longer than the distance between spur pairs with *P. neis* and allied species. Simple valva without a lacinia and weak socii are also characters of *Phrudocentra.* Both species are similar to one another in their wing markings, dull olive grey with a large triangular pale blotch at forewing costa. However, some traits shared with the previous *niveiceps* group, a short genital capsule with tegumen longer than vinculum (i.e., which is not distended), a juxta shorter than wide, and a long spine of cochlear, differentiates them from other species groups discussed above and against typical *Phrudocentra* and *Lissochlora* as well. A new genus ***Lissocentra*** **Viidalepp & Lindt, gen. n.** is proposed for these (type species: *Phrudocentra hydatodes* Warren, 1906).

Acknowledgements

The authors would like to thank their companions during field work and private lepidopterists allowing access to their collections, A. Selin (Tallinn, Estonia) and I. Renge (Tartu, Estonia). Ms Linda Pitkin and her colleagues at the British Museum and A. Hausmann in ZSM, Munich, allowing study of collections under their curation. A Sys-Resource stipendium from The Trustees of the British Museum and grant 7682 from the Estonian Science Foundation are acknowledged. Dr. A. Vives Moreno kindly provided the translation of the text of Abstract to Spanish.

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(Recibido para la publicación / *Received for publication* 21-II-2011)
(Revisado y aceptado / *Revised and accepted* 1-IX-2011)
(Publicado / *Published* 30-VI-2012)

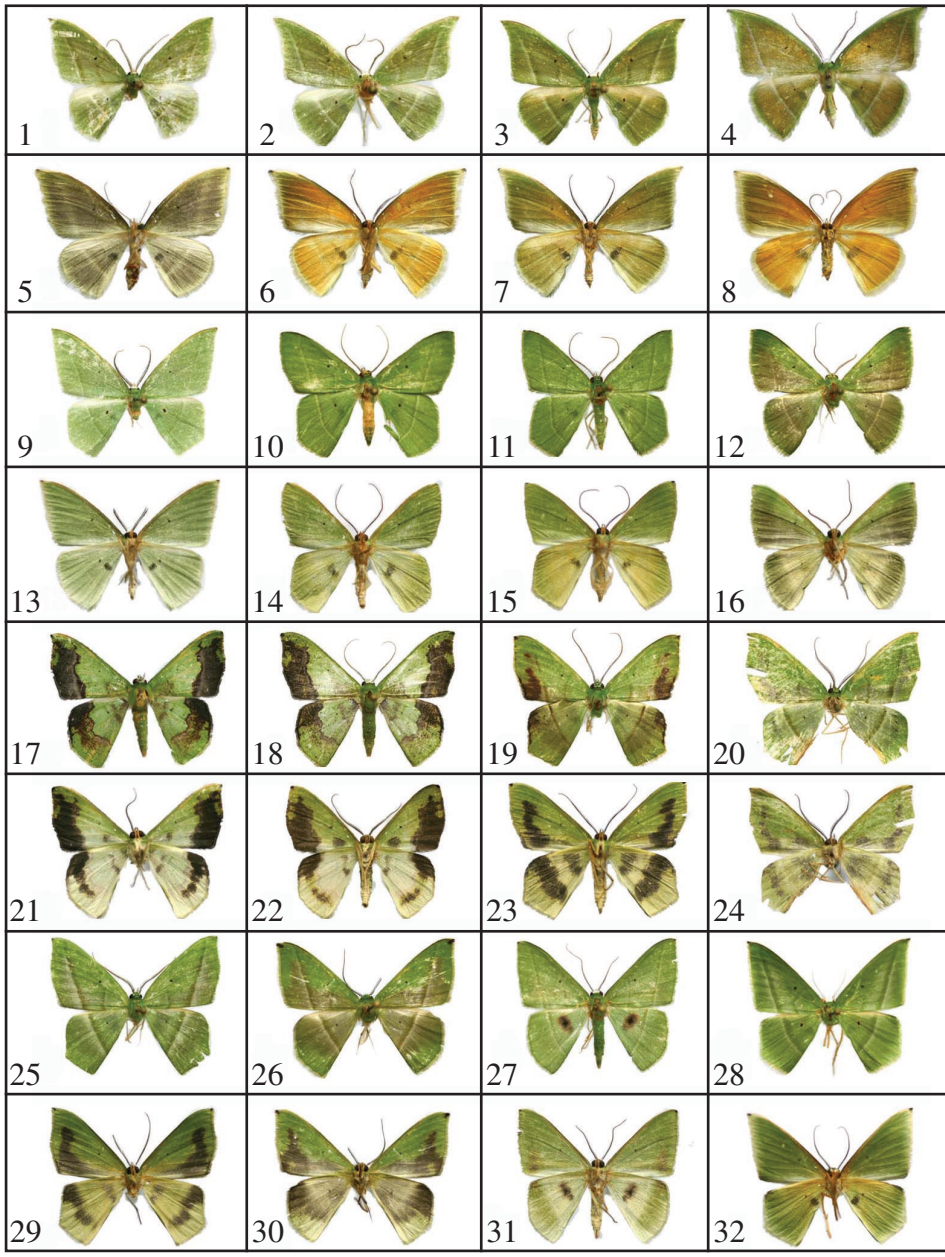

Plate 1.– Moths, above and underneath of wings. **Figs. 1-32.– 1, 5.** *Assachlora assa*; **2, 6.** *A. julietae* Viidalepp & Lindt, sp. n. (Peru); **3, 7.** *A subaurata* (green form), **4, 8.** *A. subaurata* (brown form); **9, 13.** *A. mitigata*; **10, 14.** *Phrudocentra pupillata*; **11, 15.** *P. vivida*; **12, 16.** *P. marcida*; **17, 21.** *P. janeira*; **18, 22.** *P. vagilinea*; **19, 23.** *P. neis*; **20, 24.** *P. trimaculata*; **25, 29.** *P. intermedia*; **26, 30.** *P. contaminata*; **27, 31.** *P. discata*; **28, 32.** *P. albiceps*.

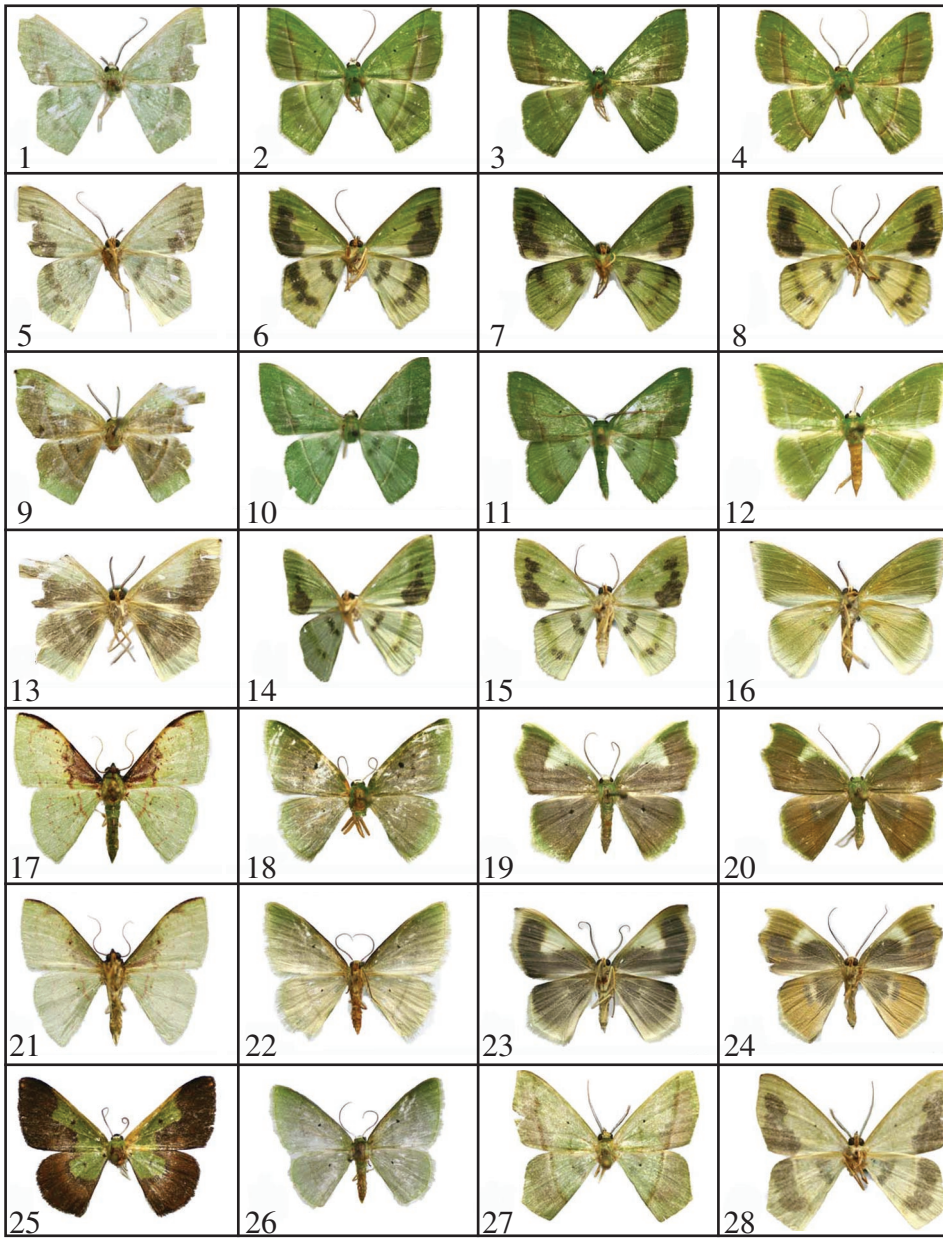

Plate 2.– Moths, above and underneath of wings. **Figs. 1-28.– 1, 5.** *Phrudocentra albicoronata*, **2, 6.** *P albicoronata sixola*; **3, 7.** *P. abscondita*; **4, 8.** *P. opaca*; **9, 13.** *P. obnubilata*; **10, 14.** *P. eccentrica*; **11, 15.** *P. genuflexa*; **12, 16.** *P. taediata*; **17, 21.** *Lindachlora flaccida*; **18, 22.** *Lissochlora senescens*; **19, 23.** *Lissocentra hydatodes*; **20, 24.** *Phrudocentra vagilinea*; **25.** *Phrudocentra nigromarginata*, **26.** *Lissocentra niveiceps*; **27, 28.** *Phrudocentra* sp.

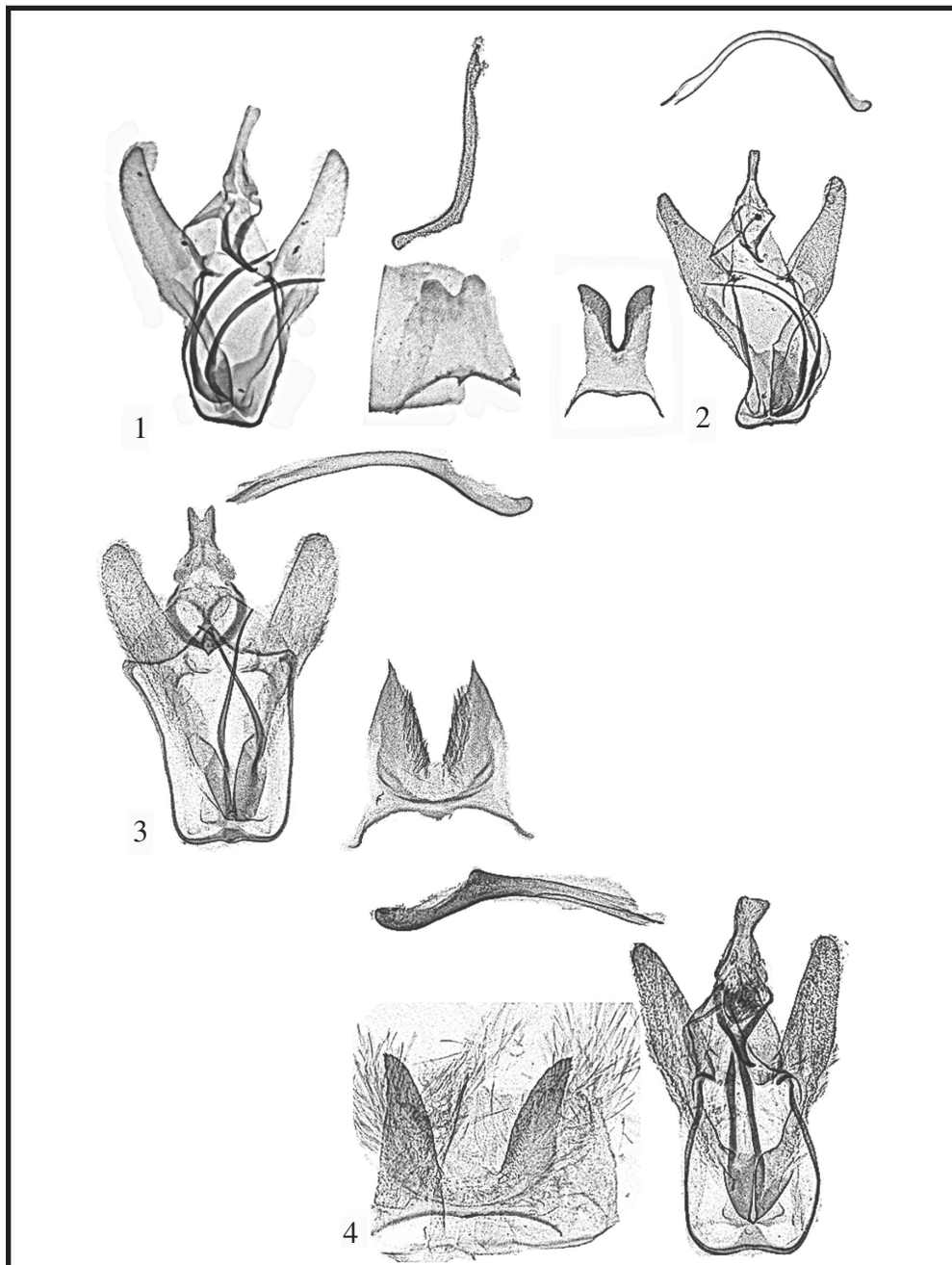

Plate 3.– Male genital structures of *Assachlora*: genital armature, aedeagus and sternite A8. **Figs. 1-4.– 1.** *A. assa*; **2.** *A. mitigata*; **3.** *A. subaurata*; **4.** *A. julietae* Viidalepp & Lindt, sp. n.

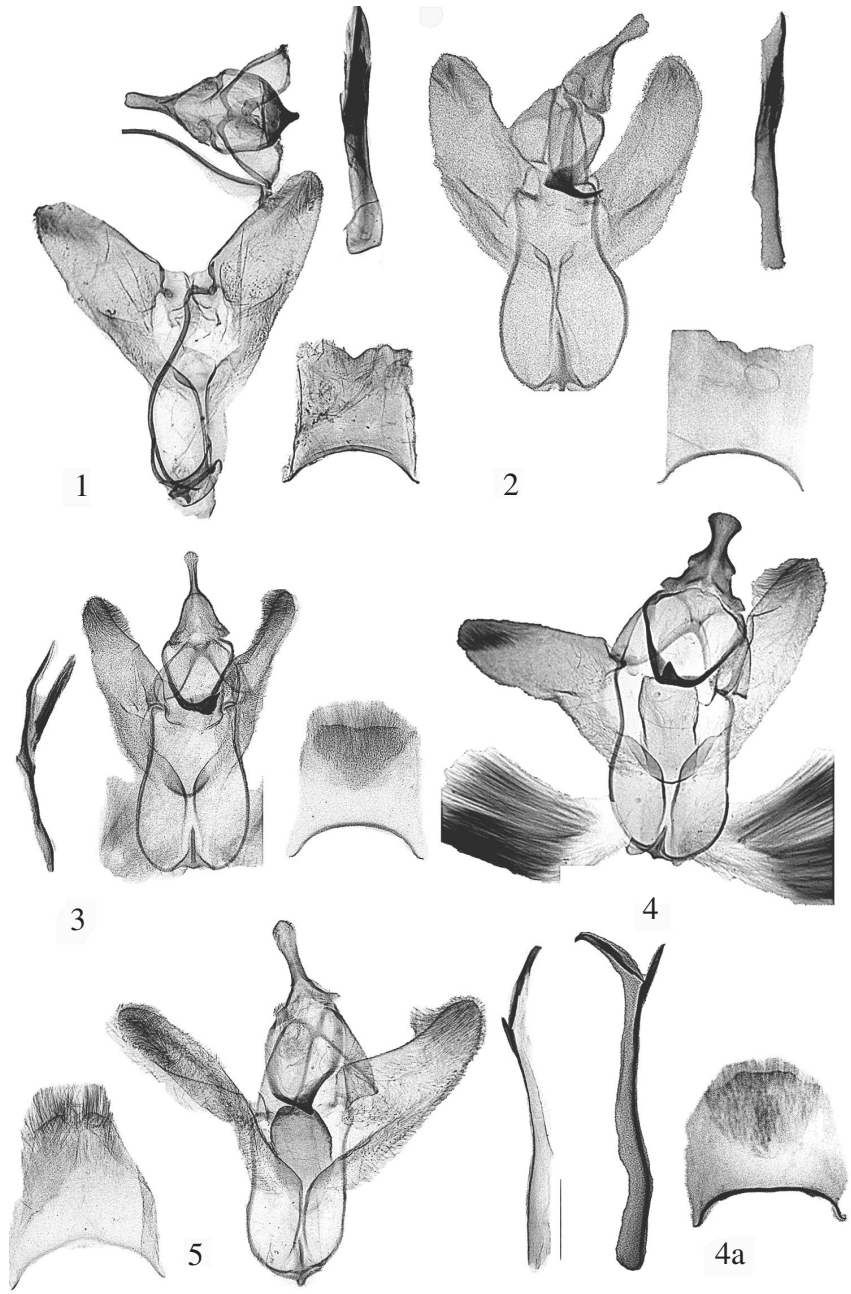

Plate 4.– Male genital structures of *Phrudocentra*; genital armature. aedeagus and sternite A8. **Figs. 1-5.– 1.** *P. pupillata*; **2.** *P. vivida*; **3.** *P. marcida*; **4, 4a.** *P. janeira*; **5.** *P. vagilinea*.

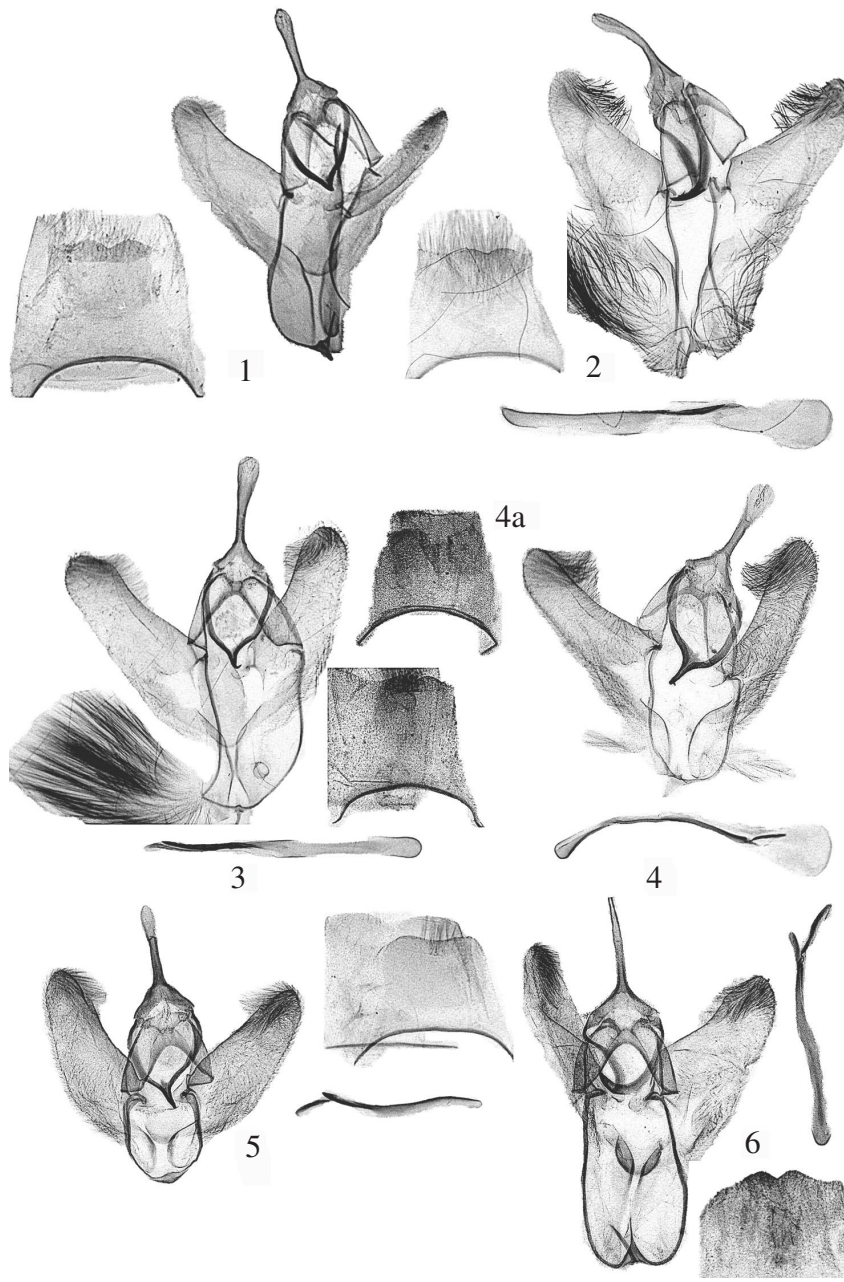

Plate 5.– Male genital structures of *Phrudocentra*; genital armature, aedeagus and sternite A8. **Figs. 1-6.– 1.** *P. neis*; **2.** *P. inguilina*?; **3.** *P. trimaculata*; **4.** *P. intermedia*; **5.** *P. contaminata*; **6.** *P. discata*.

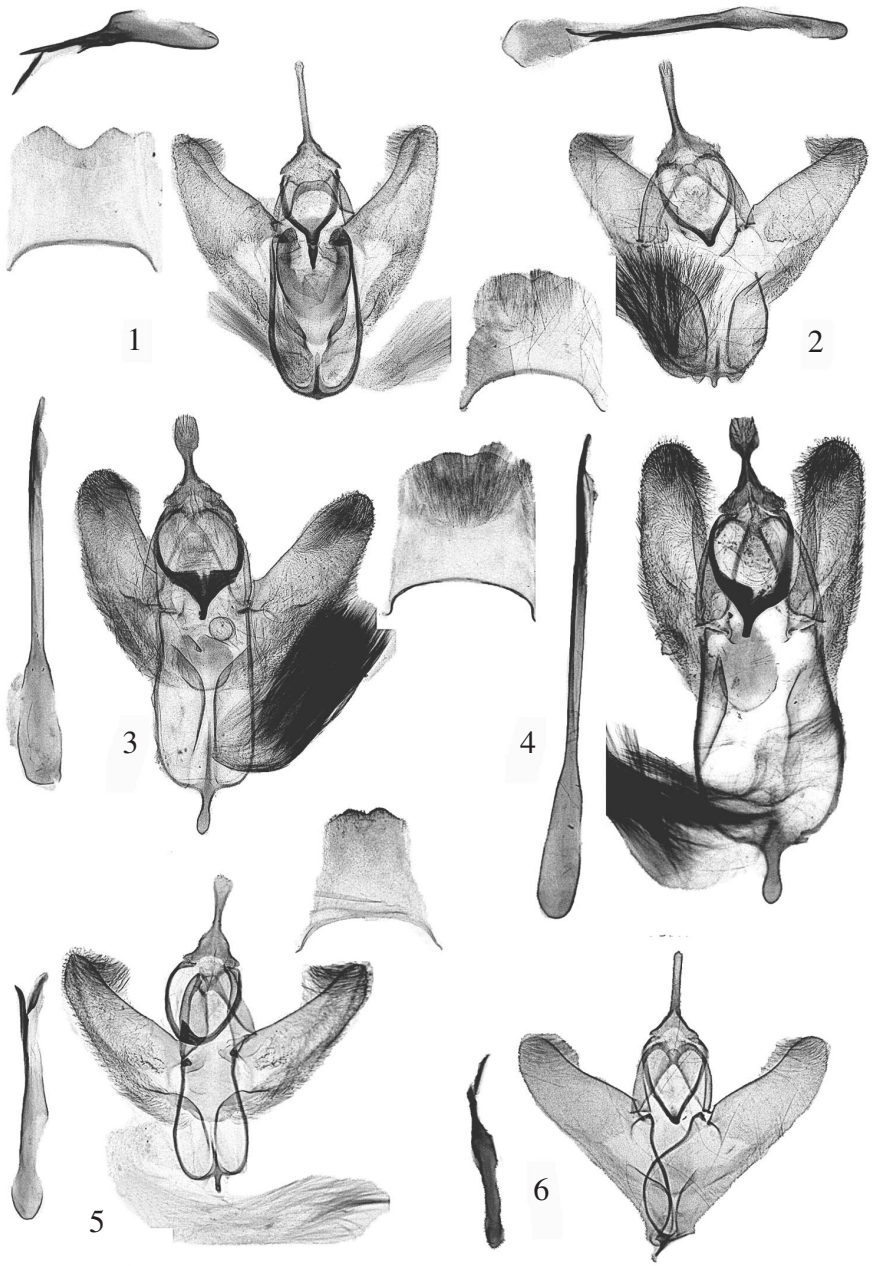

Plate 6.– Male genital structures of *Phrudocentra*; genital armature, aedeagus and sternite A8. **Figs. 1-6.– 1.** *P. albiceps*; **2.** *P. abscondita abscondita*; **3.** *P. a. albicoronata*; **4.** *P. a. sixola*; **5.** *P. opaca*; **6.** *P. obnubilata*;

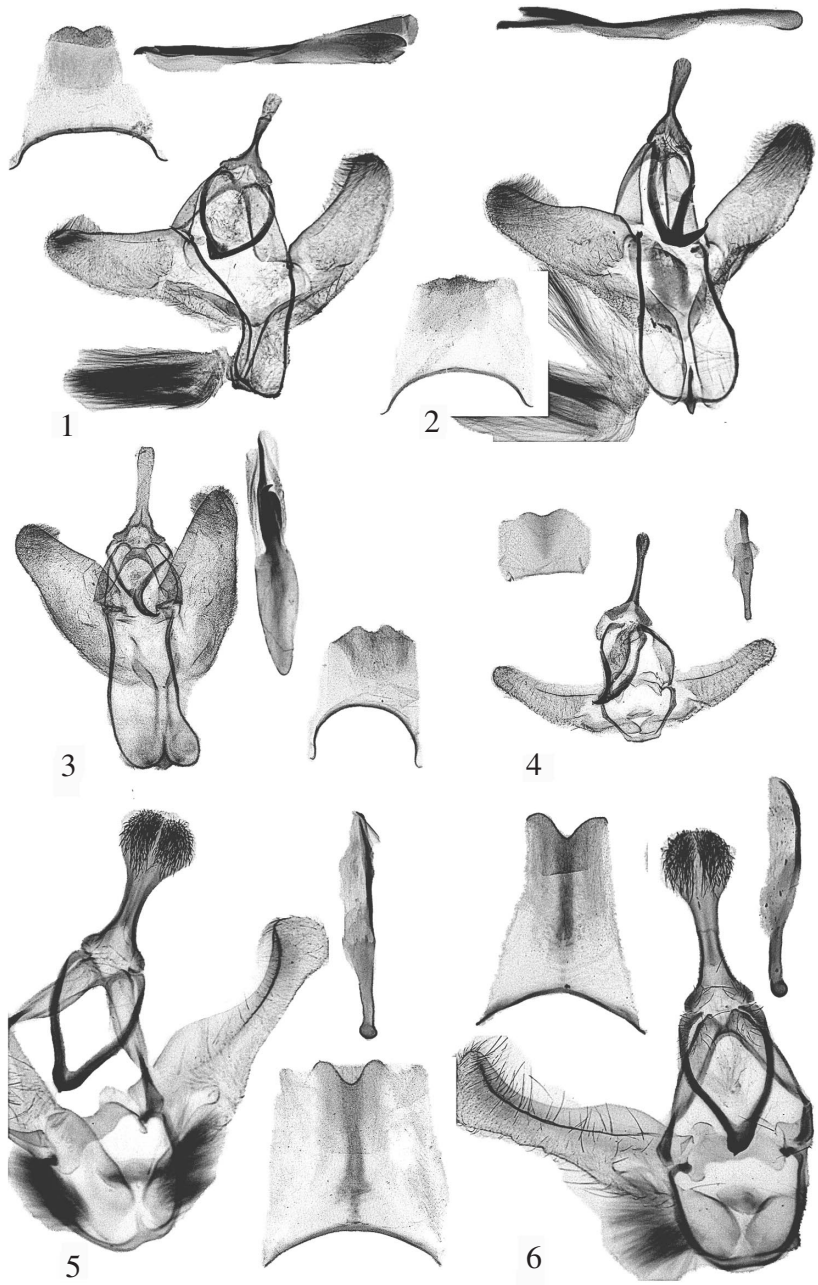

Plate 7.– Male genital structures öf *Phrudocentra* and *Lindachlora*; genital armature, aedeagus and sternite A8. **Figs. 1-6.– 1.** *P. eccentrica*; **2.** *P. genuflexa*; **3.** *P. taediata*; **4.** *P. nigromarginata*; **5.** *L. flaccida*; **6.** *L. tanystys*.

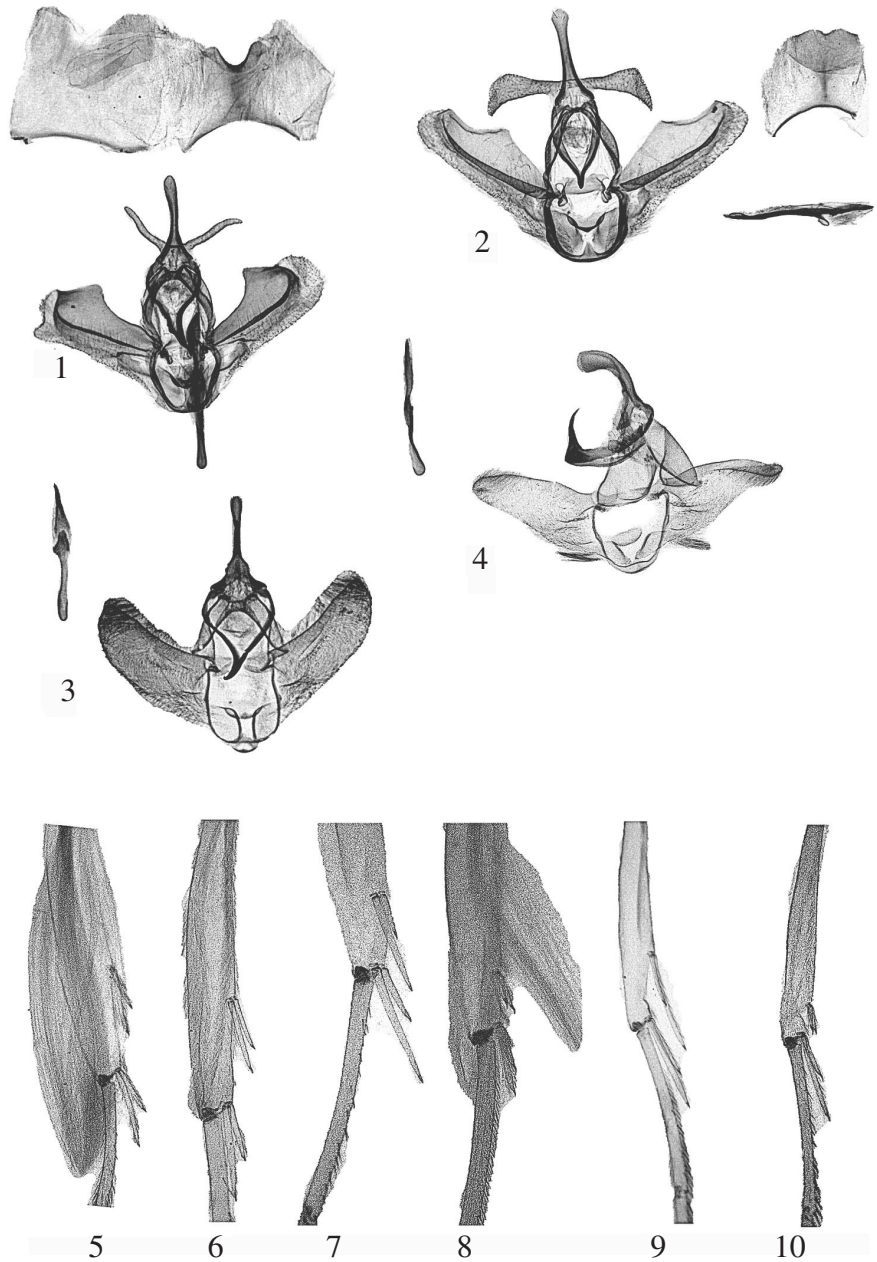

Plate 8.– Male genital structures of *Lissochlora* and *Lissocentra*; genital armature, aedeagus and sternite A8. **Figs. 1-10.– 1.** *P. niveiceps*; **2.** *P. senescens*; 3. *P. hydatodes*; **4.** *P. vitiosaria*. Distal part of male hind tibia. **5.** *Phrudocentra pupillata*; **6.** *P. vivida*; **7.** *P. discata*; **8.** *Lindachlora flaccida*; **9.** *Lissocentra hydatodes*; **10.** *Phrudocentra nigromarginaria.*